REMARKS

The Examiner has rejected claims 1-3, 9, 10, and 18 under 35 U.S.C. 103 (a) as being unpatentable over Harting et al. (U.S. Patent 5,427,665) in view of Shinriki et al. (U.S. Patent 6,063,703). Applicants respectfully traverse this rejection.

Claims 1, 2, 9, 10

Shinriki discloses "a later stage of the first step of forming a TiN film 15 of 50 nm thick, for example, on the Ti film 17. The TiN film 15 was formed under appropriate conditions, for example, a pressure of 0.1 Torr and substrate temperature of 650° C. by feeding TiCl4 and ammonia gases as reactants at a flow rate of 0.5 and 10 SCCM, respectively, while adding 10 SCCM of hydrogen." *Shinriki* is thus disclosing hydrogen flow in a chemical vapor deposition (CVD) process. The use of CVD process in the TiN film formation of *Shinriki* is further illustrated by the following references: "... includes depositing a film composed mainly of TiN by a CVD process" (Col. 3, lns. 45-46); "a second step of depositing a TiN film by a low pressure CVD" (Col. 4, lns. 27-28); "a later stage of the first step of forming a TiN film 17 by a CVD process" (Col. 9, lns. 40-41). *Shinriki* in no way teaches or suggests "depositing the metal layer onto the substrate by **physical vapor deposition** of the source metal wherein the atmosphere in the deposition chamber comprises hydrogen and the hydrogen is **activated**" as recited in claim 1 (emphasis added). An electric field or arc may be used to activate the hydrogen, but the increased substrate temperature disclosed by *Shinriki* is not sufficient.

Applicants respectfully suggest that the Examiner's combination of *Hartig* and *Shinriki* is inappropriate in this case. *Hartig* discloses "ions in the plasma" and "sputtering." (Col. 3, lns 1-15). These references indicate a physical vapor deposition (PVD) process. The Examiner's citations in *Shinriki* are directed to CVD processes. One would not normally take techniques from a CVD process and apply it to a PVD process. While the PVD process is primarily one of momentum transfer, the CVD process is primarily an active chemical reaction.

Applicants assert that claim 1 is patentable for at least the foregoing reasons and request withdrawal of the rejection.

Applicants assert that claims 2, 9, and 10 are patentable for substantially the same reasons as claim 1 and request withdrawal of their rejection.

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Claim 3, 18

The Examiner states that "Shinriki et al. further disclose the interconnect (14) comprising a titanium layer (17) of preferential orientation formed over the substrate (11)." Applicants respectfully suggest that the Examiner has mischaracterized the reference. *Shinriki* discloses a TiN layer of enhanced orientation. "By nitriding the surface of the Ti film 17, there is formed a TiN layer of enhanced (111) orientation which helps further enhance the (111) orientation of the TiN film 15 deposited thereon." (Col. 11, lns. 42-45). Nowhere is taught or disclosed a "metal layer [which] has a preferred orientation," "wherein the metal is titanium and the titanium layer has a preferred <0002> crystal orientation" as recited in claim 1 and dependent claim 3. In fact, *Shinriki* teaches away from this deposition of Ti with a preferred orientation. Shinriki states: "This means that the Ti film 17 may be a continuous film or a discontinuous film including island-like and particulate films." (Col. 10, lns. 12-15). "It is to be noted that even when no Ti film 17 is interposed, both orientation and fill-up property can be met at the same time insofar as a first TiN sub-film having (111) preferential orientation is thinly deposited ..." (Col. 14, lns. 40-44). *Shinriki* simply does not teach or disclose a metal layer "wherein the metal is titanium and the titanium layer has a preferred <0002> crystal orientation" as recited in claim 3.

Applicants assert that claim 3 is allowable for at least the foregoing reasons and request withdrawal of the rejection.

The Examiner has rejected claims 4, 11-14, 20 and 21 under 35 U.S.C. 103(a) as being unpatentable over *Hartig et al.* in view of *Shinriki et al.* as applied to claims 1-3, 9, 10 and 18 in further view of Miyasaka (U.S. Patent 6,124,154). Applicants respectfully traverse this rejection.

Miyasaka discloses a process wherein "the crystallization in the first process step is carried out by melt crystallization, by means such a laser irradiation for example, or rapid thermal annealing." (Col. 5, lns. 57-60) *Miyasaka* is directed to the problem where "silicon oxide species formed on top of semi-conductor layer 25B or impurities from the resist or other sources may be incorporated in to the semiconductor layer (mostly into source and drain regions) during laser melting." (Col. 2, lns. 54-58). *Miyasaka* discloses a process technology other than "depositing the metal layer on a substrate by physical vapor deposition," as recited in claim 1 and its dependent claim 4, and as recited in claim 18 as amended. *Miyaksaka* discloses a technology other than "sputter depositing the metal layer onto the substrate by applying power to the metal target," as recited in claim 11 as amended, and in claim 20 and its

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dependent claims 21 and 22. One would not look to a melt crystallization process for techniques to be applied to a PVD process. Further, the Examiner's restatement of the rejections of claims 1-3, 9, 10 and 18 directed now to claims 4, 11-14, 20 and 21 are traversed for the reasons stated above. Applicants assert that claims 4, 11-14, 20 and 21 are patentable for at least the foregoing reasons. Applicants request withdrawal of this rejection.

The Examiner has rejected claims 5 and 8 under 35 U.S.C. 103 (a) as being unpatentable over *Hartig et al.* in view of *Shinriki et al.* as applied to claims 1-3, 9, 10, and 18 in further view of Cava et al. (U.S. Patent 5,473,456). Applicants traverse this rejection.

Cava discloses the preparation of pellets from powder to be used in a sputter process. (Col. 2, lns. 20-67). *Cava* discloses that after the firing step that "[t]he pellets are cooled after this heating step at the natural cooling rate of the furnace." (Col. 2, lns. 41-42). *Cava* goes on to state "for applications which do not require the highest conductivity, pellets of undoped GaInO3 after firing can be heated in a reducing ambient (e.g. nitrogen-hydrogen (15 mole percent hydrogen) at 600-650 C.)." (Col. 2, lns. 63-66). The pellet formation is separate from the sputtering disclosed. Applicants assert that the Examiner has mischaracterized this pellet formation step as "forming a layer over a substrate (13) in a sputtering chamber (11) with a target (10) in atmosphere that contains 15 mole percent hydrogen," as stated in the Office Action. *Cava* does not teach or disclose "flowing a gas mixture comprising at least 0.1 molar percent hydrogen while sputter depositing the titanium layer," as recited in claim 5 and its dependent claim 8. Applicants assert that claims 5 and 8 are patentable for at least the foregoing reasons. Applicants request withdrawal of the rejection of claims 5 and 8.

The Examiner has rejected claims 6, 7, 16 and 17 under 35 U.S.C. 103(a) as being unpatentable over *Hartig et al.*in view of *Shinriki et al.* and *Miyasaka* as applied to claims 1-4, 9-14, 20 and 21 in further view of Kalyeros et al. (U.S. Patent 6,139,922). Applicants traverse this rejection. Applicants assert that claims 6, 7, 16, and 17 are patentable for substantially the same reasons stated as claims 4, 9-14, 20 and 21.

The Examiner has rejected claims 19 and 22 under 35 U.S.C. 103(a) as being unpatentable over *Hartig et al.* in view of *Shinriki et al.* and *Miyasaka* as appplied to claims 1-4, 9-14, 20 and 21 in further view of Hsu et al. (U.S. Patent 6,329,282). Applicants assert that claims 19 and 22 are patentable for at least the reasons stated above with regard to claims 18 and 20, upon which they depend.

Applicants assert that all claims are patentable over the cited references. Applicants request withdrawal of all rejections as allowance of all pending claims.

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Appendix A - Version with markings to show changes made

Additions are in bold typeface and underlined. Deletions are in bold typeface and enclosed in brackets.

1. A method of forming an oriented metal layer on a substrate, the method comprising:

placing the substrate in a deposition chamber comprising a source of metal; and

depositing the metal layer onto the substrate by physical vapor deposition of the source of metal under conditions wherein the atmosphere in the deposition chamber comprises hydrogen and wherein the hydrogen is activated, whereby the metal layer has a preferred crystal orientation.

2. The method of Claim 1 wherein the source of metal is a sputtering target and wherein depositing the metal layer onto the substrate is sputter depositing the metal layer by applying power to the sputtering target.

3. The method of Claim 2 wherein the metal is titanium and the titanium layer has a preferred <0002> crystal orientation.

4. The method of Claim 2 wherein the atmosphere comprises argon and hydrogen.

5. The method of Claim 3 further comprising flowing a gas mixture comprising at least 0.1 molar percent hydrogen while sputter depositing the titanium layer.

6. The method of Claim 3 wherein applying power to the target is providing a power density on the target of at least about 0.5 watt per square centimeter of target area.

7. The method of Claim 6 wherein applying power to the target is providing a power density on the target of between about 3 and about 8 watts per square centimeter of target area.

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8. The method of Claim 5 wherein the concentration of hydrogen in the atmosphere is at least a factor of 3 higher than the concentration of hydrogen in the sputtering chamber when sputter depositing by a process in which no hydrogen is deliberately introduced into the sputtering chamber.

9. The method of Claim 2 further comprising, after placing the substrate in the deposition chamber:

introducing a quantity of hydrogen into the deposition chamber without providing power to the target.

10. The method of Claim 9 wherein introducing a quantity of hydrogen is flowing a gas comprising hydrogen into the deposition chamber.

11. (Amended) A method of forming an oriented titanium layer on a substrate, the method comprising:

placing the substrate in a sputtering chamber comprising a titanium target;

flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector; and

sputter depositing the metal layer onto the substrate by applying power to the metal target and by providing a second gas in the sputtering chamber through a second gas injector, **wherein the hydrogen is activated and** whereby the deposited metal layer has a preferred crystal orientation.

12. The method of Claim 11 wherein the first gas comprises argon and hydrogen.

13. The method of Claim 12 wherein the second gas is an inert gas.

14 The method of Claim 12 wherein the first gas injector is positioned proximate the target.

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15. The method of Claim 14 wherein the titanium target is planar and wherein flowing the first gas provides a quantity of hydrogen in the sputtering chamber that is at least 0.5×10^{-4} standard cubic centimeters of hydrogen per square centimeter of target surface area.

16. The method of Claim 11 wherein applying power to the target is providing a power density on the target of at least about 0.5 watt per square centimeter of target area.

17. The method of Claim 16 wherein applying power to the target is providing a power density on the target of between about 3 and about 8 watts per square centimeter of target area.

18. (Amended) A method of depositing an oriented aluminum layer, the method comprising:

depositing **a** **[an oriented]** titanium layer **[according to the method of Claim 3;]** **wherein the depositing a titanium layer comprises:**

placing the substrate in a deposition chamber comprising a source of titanium; and

depositing the titanium layer onto the substrate by physical vapor deposition of the source of titanium under conditions wherein the atmosphere in the deposition chamber comprises hydrogen and wherein the hydrogen is activated, whereby the tianium layer has a <0002> preferred crystal orientation; and

depositing an aluminum layer overlying the titanium layer, whereby the aluminum layer has a preferred <111> crystal orientation.

19. The method of Claim 18 whereby a full width at half maximum of a <111> X-ray diffraction signal of the aluminum layer is less than about 1.5 degrees.

20. (Amended) A method of depositing an oriented aluminum layer, the method comprising:

depositing **[an oriented]** **a** titanium layer **[according to the method of Claim 11;]** **the titanium layer deposition comprising**

placing the substrate in a sputtering chamber comprising a titanium target;

flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector; and

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sputter depositing the metal layer onto the substrate by applying power to the metal target and by providing a second gas in the sputtering chamber through a second gas injector, wherein the hydrogen is activated and whereby the deposited metal layer has a preferred crystal orientation; and

depositing an aluminum layer overlying the titanium layer, whereby the aluminum layer has a preferred <111> crystal orientation.

21. The method of Claim 20 further comprising depositing a titanium nitride layer overlying the titanium layer, whereby the titanium nitride layer has a preferred <111> crystal orientation.

22. The method of Claim 20 whereby a full width at half maximum of a <111> X-ray diffraction signal of the aluminum layer is less than about 1.5 degrees.

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